CAI/O

INTERFACE MODULE
OPERATION MANUAL

CAI Instruments Inc.
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PLEASE NOTE IMPORTANT

MAKE THE FOLLOWING CHANGES IN THE CAI/O INTERFACE MODULE OPERATION MANUAL

PAGE 7 BOTTOM OF PAGE

CHANGE: IF YOUR COMPUTER IS THE MAIN DEVICE IT IS CALLED A DCE (DATA COMMUNICATION EQUIPMENT) AND YOU WILL USE A MALE DB-25. IF YOUR COMPUTER IS TO BE A TERMINAL TO A MAIN COMPUTER THEN IT IS A DTE (DATA TERMINAL EQUIPMENT) AND USES A FEMALE DB-25.

```
100  LET K=14336
110  POKE K+3,128
120  POKE K,155
130  POKE K+1,3
140  POKE K+2,3
150  L=PEEK (K)
160  POKE K+4,2
170  FOR I=32 TO 88
180  IF PEEK (K+5) AND 32=0 THEN 110
190  GOTO 180
200  POKE K,I
210  PRINT I;"";
220  IF PEEK (K+5)=96 THEN GOTO 140
230  L=PEEK K
240  PRINT L;"";
250  NEXT I
260  PRINT ""
270  PRINT "TEST COMPLETE"
280  PRINT "PARALLEL TEST"
290  K=15360
300  POKE K+3,130
310  POKE I=1 TO 255
320  POKE K,I
330  L=PEEK (K+1)
340  PRINT I,L
350  NEXT I
360  PRINT "END OF TEST"
```

YOUR CAI/O BOARD HAS BEEN RECONFIGURED TO OCCUPY MEMORY IN THE 8-16 K REGION PLEASE USE THE FOLLOWING PROGRAM FOR SERIAL PARALLEL TEST

IS THE MAIN DEVICE IT IS CALLED
CATION EQUIPMENT) AND YOU WILL
5. IF YOUR COMPUTER IS TO BE
AIN COMPUTER THEN IT IS A DTE
UIPMENT) AND USES A MALE DB-25.

TO DCE (FEMALE BD-25)
) TO DTE (MALE DB-25)

AD 40 POKE K,I

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TO READ: IF YOUR COMPUTER IS THE MAIN DEVICE IT IS CALLED DCE (DATA COMMUNICATION EQUIPMENT) AND YOU WILL USE A FEMALE DB-25. IF YOUR COMPUTER IS TO BE A TERMINAL TO A MAIN COMPUTER THEN IT IS A DTE (DATA TERMINAL EQUIPMENT) AND USES A MALE DB-25.

PAGE 8 TOP OF PAGE

CHANGE: DCE (MALE BD-25) TO DCE (FEMALE BD-25)

CHANGE: DTE (FEMALE DB-25) TO DTE (MALE DB-25)

PAGE 12 PARALLEL TEST

CHANGE: 40 POKE K,1 TO READ 40 POKE K,I

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INTRODUCTION

You have just purchased a system of electronic components which will allow your Sinclair ZX computer to communicate with computer systems, control external devices and communicate over telephone lines via a modem.

The following pages are a general discription of the CAI/O interface module. For specific applications not covered in this manual, please contact CAI Instrument, Inc.

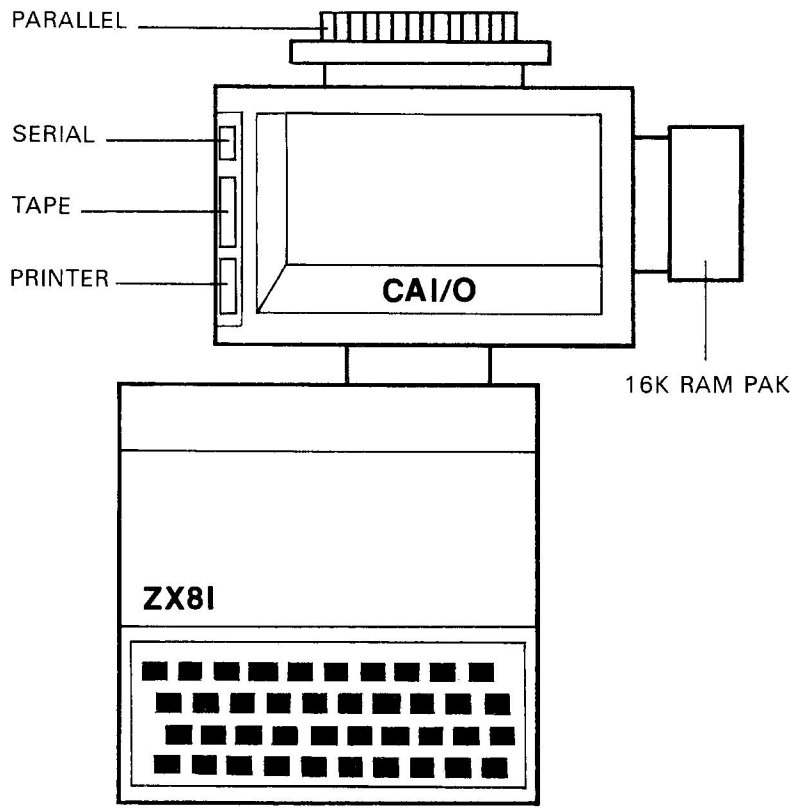
CONNECTING THE CAI/O MODULE

The CAI/O module plugs into the edge connector on the rear of your Sinclair computer. If you have a 16K memory module, it will plug into the right hand side of the CAI/O module (as shown in the diagram on the following page).

The parallel connector is at the rear of the module. It provides 24 I/O lines which can be used as input or output lines.

The serial connector is on the left at the rear. This 10 pin connector provides send, receive, and modem control for RS-232 serial communication.

If you have a CAI printer it will plug into the front left connector and the CAI tape system will plug into the middle left connector.



GLOSSARY

ASCII (American Standard Code for Information Interchange): This is a 7 bit code capable of representing letters, numbers, punctuation marks, and control codes in a form acceptable to computers and peripherals.

Baud Rate: This term is used to mean bit rate or data rate, the rate in bits per second at which information is transmitted over a serial communication link.

Data Set: Bell Telephone's name for a modem. It is used to transmit digital data over voice telephone lines.

Data Terminal: This is a class of devices with keyboards and video display (a video display terminal).

Handshake: It is the signaling protocol for transferring information between devices in a synchronized manner at a rate acceptable to both devices.

I/O (Input/output): I/O is a set of processes for information transfer into and out of a computer.

MODEM: This device provides the modulation/demodulation or modem function needed to communicate digital data over voice-grade telephone lines.

PARALLEL I/O: Data is transferred in bit-parallel format, with the width of the interconnect bus generally equal to the word size of the processor or the peripheral. The ZX-80 is an 8-bit processor, therefore theCAI/O module has 8-bit parallel ports.

PERIPHERAL: This device is connected to a computer for providing data to, or accepting data from, the external environment.

RS-232: This standard defines the interfacing between data terminal equipment and data communications equipment employing serial binary data interchange. Voltages below -3 volts are called mark potentials; above 3 volts are called space voltages.

SERIAL I/O: This is a type of interconnection in which information is transferred one bit at a time. The most common serial I/O hardware schemes are the RS-232 standard and the 20-mA current loop.

STROBE: It is a control signal for information transfers at the hardware level.

TTL (Transistor-Transistor Logic): TTL is an integrated circuit logic family characterized by high speeds, medium power requirements, and wide use.

WORD: The smallest unit of information that may be handled conveniently (addressed) by a computer is the word. The ZX-80 and ZX-81 have an 8-bit binary word (0 to 255 in decimal).

SERIAL I/O OPERATION

The serial I/O is a programmable ACE (asynchronous communications element) with RS-232 buffers for serial communication. The ACE has programmable baud rate, modem control, word length and stop bits, and can be programmed and tested to send and receive data by addressing memory locations 63488 to 63494. However, first the ACE must be programmed.

There are four steps to programming the ACE.

1. Enable control register 3 to accept baud rate divisor.

2. Baud Rate-the rate is broken down into two words, the LSW (least signifigant word) and MSW (most signifigant word) See Word Length Table.

3. Word Length-this sets the number of bits in a word to either 5, 6, 7 or 8. The word length is set with the data values given in the Word Length Table on the following page.

4. Clear to Send-testing this tells you the device you are connected to is ready to communicate.

The following sample program shows the BASIC statements needed to program the ACE for normal RS-232 communications at 300 baud.

```
10 LET K=63488          (memory location of ACE)
20 POKE K+3,128         (initiate baut rate select)
30 POKE K,155           (set LSW of baud rate)
40 POKE K+1,2           (set MSW of baud rate)
50 POKE K+3,3           (set word length to 8)
60 POKE K+4,2           (set RTS)
```

At this point you are ready to send and/or receive serial data. To send data you must first check to see if the device you are transmitting to is listening. This is accomplished by testing the CLS (clear to send). If the CLS is set the next step is to test the transmitter buffer to see that it is empty before writing new data into it. If both these conditions have been met the computer is ready to send a character. The following is a BASIC routine can be used to transmit data.


```
100 IF PEEK (K+6) AND 16=16 THEN GOTO 100 (test CLS)
110 IF PEEK (K+5) AND 32=0 THEN GOTO 110 (test buffer)
120 POKE K, L                             (send variable L)
```

To receive data you must first clear the input buffer. Then, tell the sending device that you are ready to recieve data. When data is received, the data available flag is set. The character is now available to the computer. The following BASIC program is a sample input routine.

```
200 LET X=PEEK K                          (clear buffer)
210 POKE K+4,1                            (set DTR)
220 IF PEEK (K+5)< >97 THEN GOTO 220(test data available)
230 LET L=PEEK K                          (input character)
```

BAUD RATE TABLE

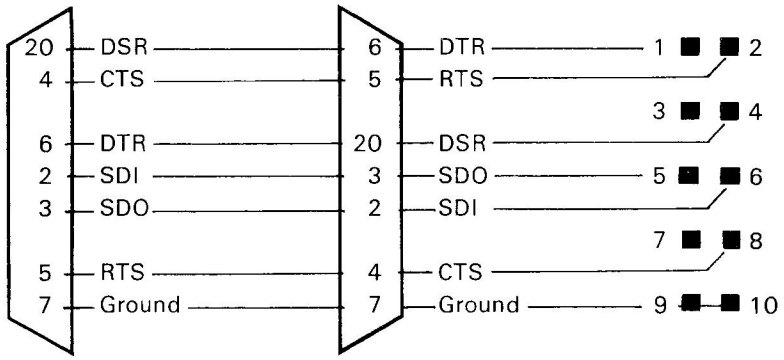
Baud Rate	=	110	300	600	1200
LSW	=	27	155	78	167
MSW	=	7	2	1	0

WORD LENGTH TABLE

Word length	=	5	6	7	8
Data	=	0	1	2	3

Unless you are communicating with another Sinclair computer the data that is sent and received must be converted to ASCII code. The ASCII CODE I/O program is a complete program to allow you to communicate in a universal computer language (Available from CAI Instruments, Inc.)

To connect the CAI/O module to a peripheral device the serial I/O connecter must be wired to match the device you intend to communicate with. The standard RS-232 connector is a male or female DB-25. If your computer is the main device it is called a DCE (data communication equipment) and you will use a male DB-25. If your computer is to be a teriminal to a main computer then it is a DTE (data terminal equipment) and uses a female DB-25. The connections are listed on the following page.



WARNING Do not connect the serial out lines to any circuits that are not capable of handling +12 and -12 volts. Please be advised that the serial I/O is not TTL compatable.

SIGNAL DISCRIPTIONS

Output signals

DTR Data Terminal Ready informs a MODEM or data set that your computer is ready to communicate.

RTS Request To Send informs a MODEM or data set that your computer is ready to send data.

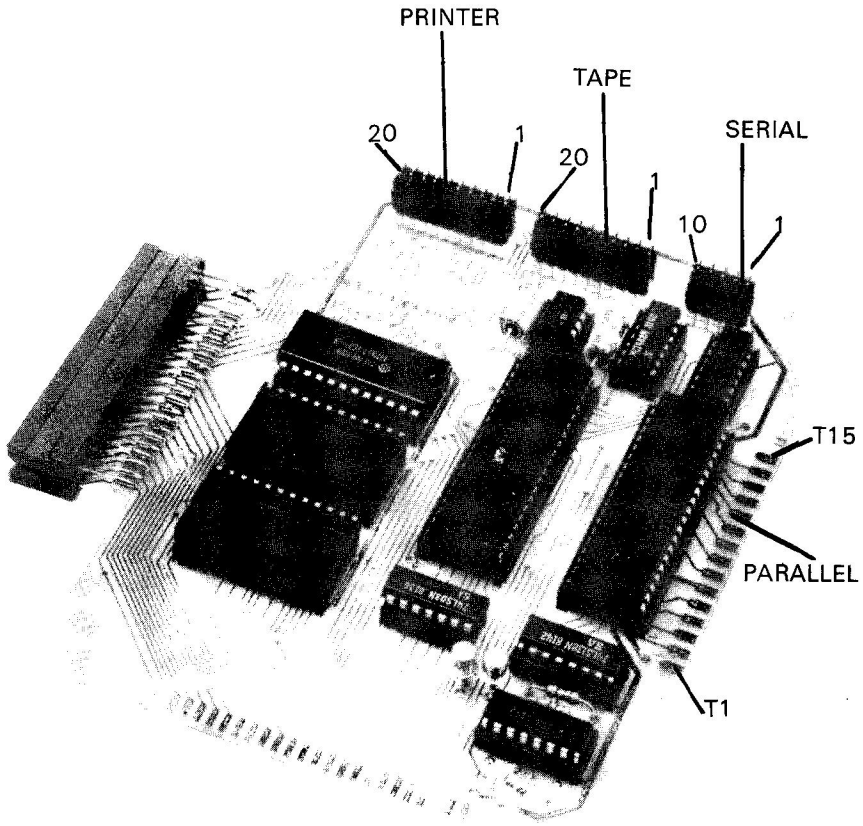
SDO Serial Data Out is the signal with data being sent by your computer.

Input signals

SDI Serial Data In is from the peripheral device.

CTS Clear To Send is a MODEM control function input whose condition can be tested by the user before sending data.

DSR Data Set Ready indicates that the MODEM or data set is ready to establish communications.



PARALLEL I/O CONTROL

The parallel I/O is controlled by a PPI(Programmable Peripheral Interface). The PPI consists of three 8 bit ports A, B, and C as well as the control register. In order to program the PPI you must write a control word into the control register. To have a port A as an output port, port B and C as inputs the control word is 130. The BASIC command is as follows.

```
10 POKE 64515,130      (Set control word)
```

For I/O with handshake the control word is 166. This sets port A as an output port with output handshaking on lines C6 and C7. It also sets port B to an input port with input handshaking on lines C1 and C2.

Output Handshake

OBF (Output Buffer Full flip-flop) The OBF output will go low to indicate that the computer has written data out to the specified port. The OBF flip-flop will be set when you POKE data into port A and will be reset by ACK (acknowledge signal from peripheral) being low.

To output data to the peripheral you POKE 64512, (data). If using handshake signals you can test bit 3 of port C by a PEEK (64514) and checking for a 3 bit. A sample program follows.

```
10 LET K=64512
20 POKE K+3,166              (set control word)
30 POKE K,31                 (set port A lines 0,1,2,3 and 4 high)
40 IF PEEK (K+2)< > 8 THEN GOTO 40 (loop until ACK resets OBF)
```

Input Handshake

STB (strobe input) A low on this input loads data into the input latch.

IBF (input buffer full flip-flop) A high on this output indicates that the data has been loaded into the input latch.

To input data into the computer use the following program.


```
10 LET K=64512
20 IF PEEK (K+2)  AND 1< > 1 THEN GOTO 20
                             (loop until data ready)
30 LET L=PEEK (K+1)          (input data port B)
```

PARALLEL CONNECTIONS

30 Pin I/O connector T=Top B=Bottom

Port A data line	- pin	Port B data line	- pin	Port C data line	- pin
0	- T6	0	- T13	0	- T10
1	- T5	1	- T14	1	- B10
2	- T4	2	- T15	2	- T11
3	- T3	3	- B15	3	- T12
4	- B3	4	- B14	4	- B9
5	- B4	5.	- B13	5	- T9
6	- B5	6	- B12	6	- B8
7	- B6	7	- B11	7	- T8

Ground is on pin T7 and B7
OBF is on pin T8
ACK is on pin B8
IBF is on pin T9
STB is on pin B9

Top and Bottom 1 and 2 are not connected.

WARNING do not connect any negative voltages or positive voltages above +5 volts to the parallel connector.

PARALLEL TEST

PORT A IS AN OUTPUT PORT, PORT B IS THE INPUT PORT. BY CONNECTING PORT A DATA LINES (0 TO 7) TO PORT B DATA LINES THIS PORGRAM WILL TEST ALL 256 COMBINATIONS. THE TV SCREEN WILL SHOW DATA OUTPUT ON THE LEFT AND DATA INPUT ON THE RIGHT.

```
10 LET K=64512
20 POKE K+3,130
30 FOR I=0 TO 255
40 POKE K,1
50 LET L=PEEK (K+1)
60 PRINT I,L
70 PRINT "PRESS NEW LINE TO CONTINUE"
80 INPUT A$
90 CLS
100 NEXT I
110 PRINT "END"
```

SERIAL TEST

THIS TEST SENDS THE ASCII CODE SET OUT. BY CONNECTING THE SERIAL DATA OUT LINE TO THE SERIAL DATA IN LINE THIS PROGRAM WILL TEST THE TRANSMITTER AND RECEIVER. THE TV SCREEN WILL SHOW THE NUMBER (32 to 89) REPRESENTING EACH ASCII CHARACTER SENT AND RECEIVED.

```
10 REM SET UP ACE
20 LET K=63488
30 POKE K+3,128
40 POKE K,155
50 POKE K+1,2
60 POKE K+3,3
70 LET L=PEEK K
80 POKE K+4,3
90 REM OUTPUT ASCII CODE SET
100 FOR I=32 TO 89
110 IF PEEK(K+5) AND 32=0 THEN GOTO 110
120 POKE K,I
130 PRINT I ; " " ;
140 IF PEEK (K+5)=96 THEN GOTO 140
150 LET L=PEEK K
160 PRINT L ; " " ;
170 NEXT I
```